STAT

Application of the Integral Method of Measuring Water Discharges and Suspended Detritus in Large Rivers

Meteorologiya i Gidrologiya, No 6, pages 93-96; I. I. [illegible]ol'chas;
Moscow/Leningrad, 1948.

STAT

THE INTEGRAL METHOD OF MEASURING WATER DISCHARGES AND [illegible] *

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The accuracy of the measurement of discharges (water and alluvial suspensions) depends to a considerable degree upon the duration of measurement; the accuracy becomes greater as the time interval decreases. From 8-12 working hours are spent in measuring one water discharge on the Volga River by the 5 point method 9-16 verticals).

Economically speaking, such lengthy duration of measurement is expensive. The introduction of the integral method of measuring water discharges and alluvial suspensions would considerably accelerate hydrometric works.

Unfortunately, the 1944 edition of instructions to hydrometeorlogical stations and posts presupposes the use of the integral method only for the measurement of alluvial suspension discharges.

The personnel of station Polyana Frunze conducted experiments on the measurement of the Volga River discharges by the integral method.

Experiments were conducted during calm weather and low water mark level. Velocity was measured by means of a Lagu hydrometer.

In order to use this method it is very important to establish the necessary speed of ascent and descent of the hydrometer, which would result in minimum discrepancies. For this purpose we have made a number of determinations, results of which are given in Table 1.

The closest results are obtained when the speed of ascent and descent of the hydrometer is 0.065-0.43 meters per second, i.e. for speed very close to the initial speed of the hydrometer, which in our opinion, approximates the truth. Having adopted the indicated speeds of ascent and descent, we conducted a number of measurements of water discharges by the 5 point and integral methods.

* [Note: This is an article that appeared in the regular "Short Reports and Notes" section of Meteorologiya i Gidrologiya, No. 6, 1948, pp 93-96.]

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TABLE 1

No In Order	5 Point Method	By the Integral Method, Using Ascent and Descent In Meters per Second			$K = \frac{v_1}{v}$	$K = \frac{v_2}{v}$	$K = \frac{v_3}{v}$
		$0.13\ v_1$	$0.065\ v_2$	$0.043\ v_3$			
1	0.55	0.50	0.52	0.56	0.91	0.94	1.02
2	0.45	0.44	0.43	0.45	0.98	0.96	1.00
3	0.45	0.43	0.44	0.46	0.96	0.98	1.02
4	0.45	--	0.46	0.45	--	1.02	1.00

Work was performed in calm weather from an anchored boat, and by fastening the hydrometer to a torpedo-shaped 120 kilogram weight, which was tied to a 7 millimeter cable divided into one meter graduations, which permitted the measurement of depth to an accuracy of 0.1 meter.

The time when the hydrometer would reach the bottom and water surface was read. The speed of ascent and descent of the hydrometer was regulated with a stopwatch, which ensured uniformity of the process. The results obtained are shown in Table 2.

As seen from Table 2, discrepancies vary between 0 to 4.7 percent, if we take as standard water discharges measured by the 5-point method and treated in a graphico-mechanical manner, which can be considered quite satisfactory.

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TABLE 2

Method of Measurement and Treatment			Percent of Discrepancy of Discharges Depending on the Method of Measurement and Treatment		
5 - Point		Integral	5 - Point		Integral
Graphico - Mechanical	Analytical	Analytical	Graphico - Mechanical	Analytical	Analytical
1,880	1,820	1,860	100	3	-1
1,920	1,900	1,850	100	-1	-3
1,990	1,950	1,980	100	-2	0
2,580	2,510	2,460	100	-3	-4.7
2,540	2,510	2,530	100	-1	0
			Average	-2	-2

The speed and simplicity of measurement and treatment of data by the integral method of discharge measurement results in great saving of working time.

Thus, in order to determine and work out a single Volga water discharge we require about 35 working hours; for the measurement and working out of a discharge by the integral method, we require only about one working day, with the resultant economy of 2-2.5 work days per one discharge.

Discrepancies between water discharges measured by the 5-point and integral depend primarily on the speed and uniformity of ascent and descent of the hydrometer which must be determined and regulated by means of a stopwatch.

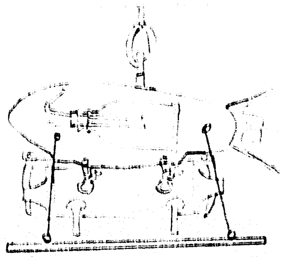
In order to verify the methods of determination and working out the discharges of suspensions used by the Hydrological meteorological service, we have, in 1940, made 30 discharge determinations employing different methods and instruments.

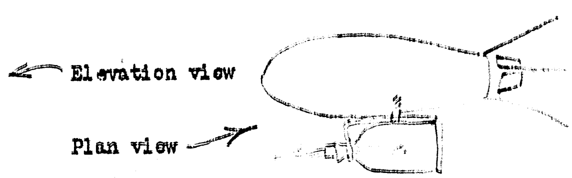
The method of obtaining samples and separation of suspensions, treatment of discharges were in strict correspondence with the instructions for river hydrological stations. To obtain better results, bathometer and bottle were of equal volume (5 liters). The method of securing Zhukovskiy's bathometer and bottle is indicated on drawing 1.

The river profile and distribution of velocity ordinates are shown on drawing 2. Samples of suspensions were taken across an ordinate. Results of the treatment are shown in Table 3. On the basis of these data we can draw the following conclusions.

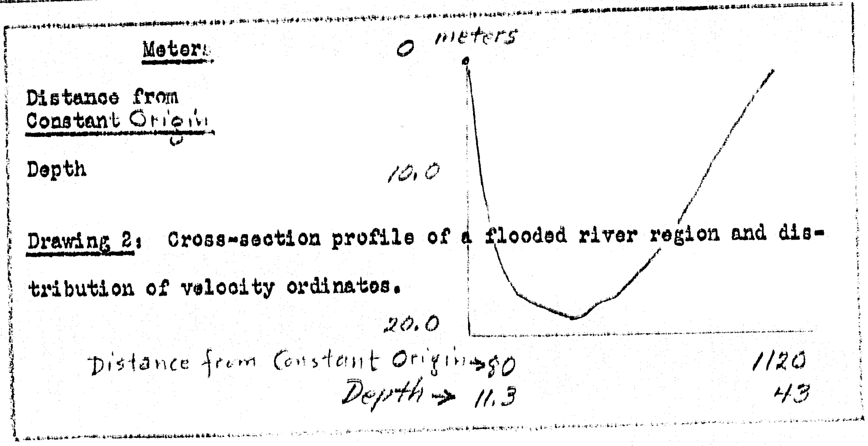
1. That the treatment of suspension samples with the separation of fractions leads to a general 20-25 percent increase in discharge.

2. That the discharges of suspensions, determined by the detailed method, differ from discharges determined by the integral method, only within the limits of accuracy of determination of discharges, i.e. discharges determined by the integral method are equivalent in quality to those determined by the detailed method.





Drawing 1



Drawing 2: Cross-section profile of a flooded river region and distribution of velocity ordinates.

TABLE 3

No In Order	Date of Discharge Determination	H Centimeters	Water Discharge, Cubic Meters per Second	Suspension Discharges (Method of Determination and Treatment of Sample)				$K=\frac{R_1}{R}$	$K=\frac{R_2}{R}$	$K=\frac{R_3}{R}$
				Zhukovskiy's Bathometer		Bottle				
				Detailed Fractions R	Without Fractions R_1	Detailed R_2	Integral R_3			
1	6/V	1,052	28,700	6,102	4,375	—	—	0.72	—	—
2	15/V	1,106	25,750	3,000	2,095	2,310	—	0.70	0.77	—
3	26/V	884	18,060	1,170	967	1,130	—	0.83	0.97	—
4	30/V	738	14,530	1,450	—	—	958	—	—	0.69
5	1/VI	668	13,137	900	—	—	720	—	—	0.82
6	4/VI	584	11,300	930	—	—	736	—	—	0.86
7	7/VI	527	10,200	960	—	—	692	—	—	0.71
8	10/VI	489	9,480	930	680	—	655	0.72	—	0.70
9	15/VI	470	8,830	726	626	—	—	0.86	—	—
10	20/VI	550	11,810	1,420	1,004	—	969	0.71	—	0.68

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
11	24/VI	587	11,920	1,400	—	1,080	1,009	—	0.77	0.72
12	3/VII	574	10,950	960	—	800	816	—	0.82	0.83
						Average		0.76	0.84	0.75

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Received by the editor March 8, 1947

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